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Stroke doctors: Who are we? A World Stroke Organization survey

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Abstract

Background: Specialist training provides skilled workforce for service delivery. Stroke medicine has evolved rapidly in the past years. No prior information exists on background or training of stroke doctors globally.

Aims: To describe the specialties that represent stroke doctors, their training requirements, and the scientific organizations ensuring continuous medical education.

Methods: The World Stroke Organization conducted an expert survey between June and November 2014 using e-mailed questionnaires. All Organization for Economic Co-operation and Development countries with >1 million population and other countries with >50 million population were included ($n = 49$, total 5.6 billion inhabitants, 85% of global strokes). Two stroke experts from each selected country were surveyed, discrepancies resolved, and further information on identified stroke-specific curricula sought.

Results: We received responses from 48 (98%) countries. Of ischemic stroke patients, 64% were reportedly treated by neurologists, ranging from 5% in Ireland to 95% in the Netherlands. Per thousand annual strokes there were average six neurologists, ranging from 0.3 in Ethiopia to 33 in Israel. Of intracerebral hemorrhage patients, 29% were reportedly treated by neurosurgeons, ranging from 5% in Sweden to 79% in Japan, with three neurosurgeons per thousand strokes, ranging from 0.1 in Ethiopia to 24 in South Korea. Most countries had a stroke society (86%) while only 10 (21%) had a degree or subspecialty for stroke medicine.

Conclusions: Stroke doctor numbers, background specialties, and opportunities to specialize in stroke vary across the globe. Most countries have a scientific society to pursue advancement of stroke medicine, but few have stroke curricula.

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Introduction

Given the overall worldwide body of knowledge in medicine increases constantly and at an accelerating rate, it is not possible to fully master the entire spectrum. Therefore, most doctors engage in specialist and subspecialty training. Further, continuous medical education, mostly provided by scientific specialist organizations, is necessary to maintain reasonable standards of practice. However, the way doctors are trained and healthcare services are delivered vary from country to country.

Over a period of a few decades, the treatment of stroke patients has transformed from passive observation on general medical wards to active, specialized care, rich in protocols and procedures. Stroke units and revascularization therapies have been the most practice-changing advances. These and various other new techniques such as carotid endarterectomy, stroke intensive care, and neurosurgical interventions require highly skilled personnel.[1,2] As a consequence, a subspecialty of "strokologists" has emerged in clinical practice,[3] but educational systems have often not formalized this development. Changes in stroke medicine will have profound effects on workforce demand in the future.[4] Currently, stroke patients are being cared for by various specialists in different settings, including neurologists, neurosurgeons, geriatricians, emergency doctors, rehabilitation specialists, and general physicians. No comprehensive data exist on global practices of educating stroke doctors.

The aim of this study was to answer three questions: Which specialties do doctors treating stroke patients represent? How are they being trained? Do they have scientific organizations to ensure quality in continuous medical education?

Methods

The study was endorsed and co-ordinated by the Young Stroke Professionals Committee of the World Stroke Organization (WSO), the global scientific organization for stroke medicine.

We performed an expert survey using short e-mailed questionnaires (Online Panel A). Two stroke experts from each selected country, at different stages of their career, and different institutes were approached and invited to participate. The respondents were primarily identified among WSO members, and if not available, through national stroke organizations, or stroke-related publications. An e-mail questionnaire accompanied by a letter of invitation was sent, followed by two reminders as needed. If no replies were received, another person from the same country was approached. The responses of the two experts from each country were compared. Any discrepancies were clarified with the experts and checked against further sources. Further descriptions of existing stroke-specific curricula were sought from the identified curriculum contacts.

We limited the scope of our study to countries which were Organisation for Economic Co-operation and Development (OECD) members with >1 million population or non-OECD countries with a population of >50 million.

Results

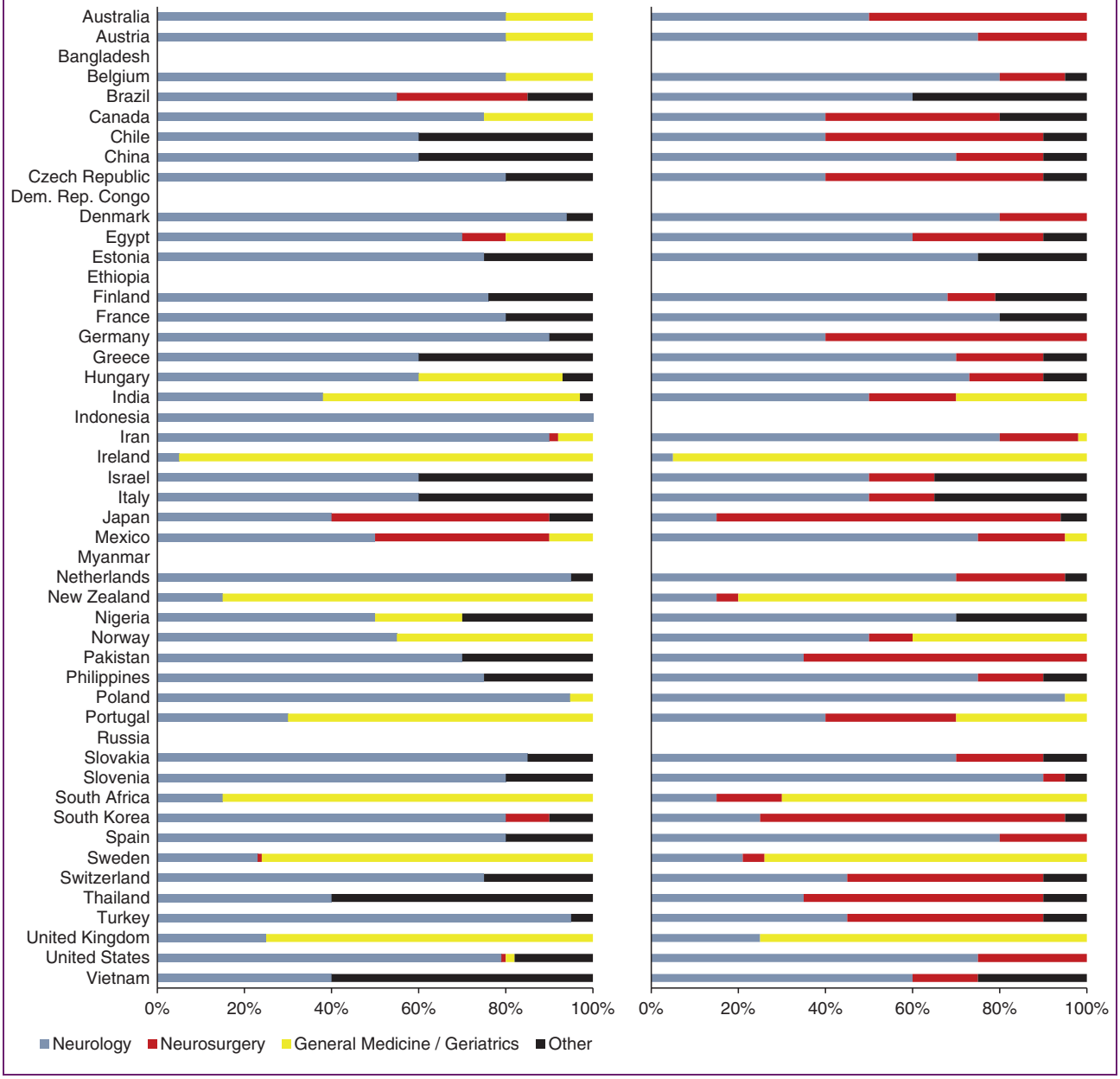
We received responses from all countries except Bangladesh, with a response rate of 98% of the countries selected. For Bangladesh, we used publicly available data on numbers of doctors. The 49 countries included represent 78% of world population, 85% of world strokes, and $>95\%$ of global stroke research output.[5]

With a few exceptions,[6–11] the experts did not identify published articles on the number of stroke patients treated by different specialties. Therefore, the country estimates of stroke doctor specialties are mainly based on expert opinion. In most countries, stroke patients were treated by neurologists. In some, mostly Commonwealth countries, general medicine was the main treating specialty. Treatment of intracerebral hemorrhage varied by country between neurology, general medicine, and neurosurgery (Figure 1). The numbers of neurologists and neurosurgeons per population differed widely by country (Table 1 and Figure 2). Also the content and duration of specialist training in neurology and neurosurgery varied across countries, being typically five years in duration, but ranging from two to seven (Online Table 1).

Ten of the included countries had a specialty, subspecialty, or similar national degree in stroke medicine. Additionally, the European Stroke Organisation has a training program in collaboration with the Donau University Krems in Austria. The duration of the stroke programs ranged from nine months to three years (Table 2). Further information on the programs is available via links in Online Panel B.

All but seven of the countries had a national stroke society. Many, but not all of these societies were

Figure 1. Proportion of ischemic stroke (left panel) and intracerebral hemorrhage (right panel) patients by treating specialty. Data are based on expert opinion with the exception of Belgium, Finland, Hungary, India, Japan, and the United States which have published data.[6–11]



member organizations of the WSO. The highest WSO member rates per population were from Australia (Table 3).

Discussion

As health service delivery in the field of stroke is rapidly evolving, and in light of the increasing stroke incidence due to an aging world population, stroke specialist training faces distinct challenges. In this survey, we, for the first time, summarized the specialist background, current curricula, and national scientific societies in stroke medicine. While the main specialty responsible for stroke in most countries was identified as neurology, many countries are an exception to this rule, and the main treating specialty of intracerebral hemorrhage varied widely. Stroke societies exist in almost every country, but stroke curricula are less common. These existing stroke programs can be utilized as a framework by countries and organizations

Table 1. Population, stroke incidence, and the numbers of neurologists and neurosurgeons.

Country	Population (millions)	Ischemic strokes[a]	Hemorrhagic strokes[a]	Neurologists	Neurosurgeons
Australia	22.3	30	9	456	120
Austria	8.3	19	6	582	100
Bangladesh	152.5	96	49	110	113
Belgium	10.9	25	7	530	180
Brazil	193.3	313	116	5000	3500
Canada	34.1	67	16	881	306
Chile	17.1	15	9	244	114
China	1341.3	3308	2305	15,000	6000
Czech Republic	10.5	43	10	1100	85
Dem. Rep. of the Congo	67.5	37	20	49	4
Denmark	5.5	14	5	237	110
Egypt	86.2	72	25	500	700
Estonia	1.3	13	2	110	15
Ethiopia	86.6	50	34	26	10
Finland	5.4	21	7	323	65
France	63.0	119	40	2100	450
Germany	81.8	285	86	4238	1464
Greece	11.3	25	8	832	200
Hungary	10.0	55	12	867	108
India	1224.6	1098	472	1100	1500
Indonesia	239.9	245	195	1200	240
Iran	77.3	288	63	700	500
Ireland	4.5	7	2	61	28
Israel	7.6	10	3	432	56
Italy	60.5	111	33	3000	720
Japan	128.1	458	180	5122	7207
Mexico	108.4	89	35	1141	956
Myanmar	56.2	49	38	22	13
Netherlands	16.6	27	9	845	130
New Zealand	4.4	6	2	40	21

(continued)

Table 1. Continued

Country	Population (millions)	Ischemic strokes[a]	Hemorrhagic strokes[a]	Neurologists	Neurosurgeons
Nigeria	173.6	96	57	80	25
Norway	4.9	10	3	324	70
Pakistan	186.0	114	54	120	150
Philippines	99.3	73	44	270	52
Poland	38.2	116	32	3000	400
Portugal	10.6	27	11	314	140
Russia	142.5	847	124	8000	2900
Slovakia	5.4	18	4	700	75
Slovenia	2.0	8	2	143	20
South Africa	56.0	49	30	155	182
South Korea	49.4	77	36	1920	2740
Spain	46.1	102	32	1607	442
Sweden	9.4	27	7	316	120
Switzerland	7.8	17	5	546	169
Thailand	65.9	114	67	750	350
Turkey	72.7	75	26	1725	1500
United Kingdom	61.3	112	34	694	265
United States	309.3	755	188	16,366	3500
Vietnam	89.7	94	85	400	250
Total in the study	**5567**	**9726**	**4638**	**84,278**	**38,478**
Non-study countries	1585 (22%)	1844 (16%)	687 (13%)		

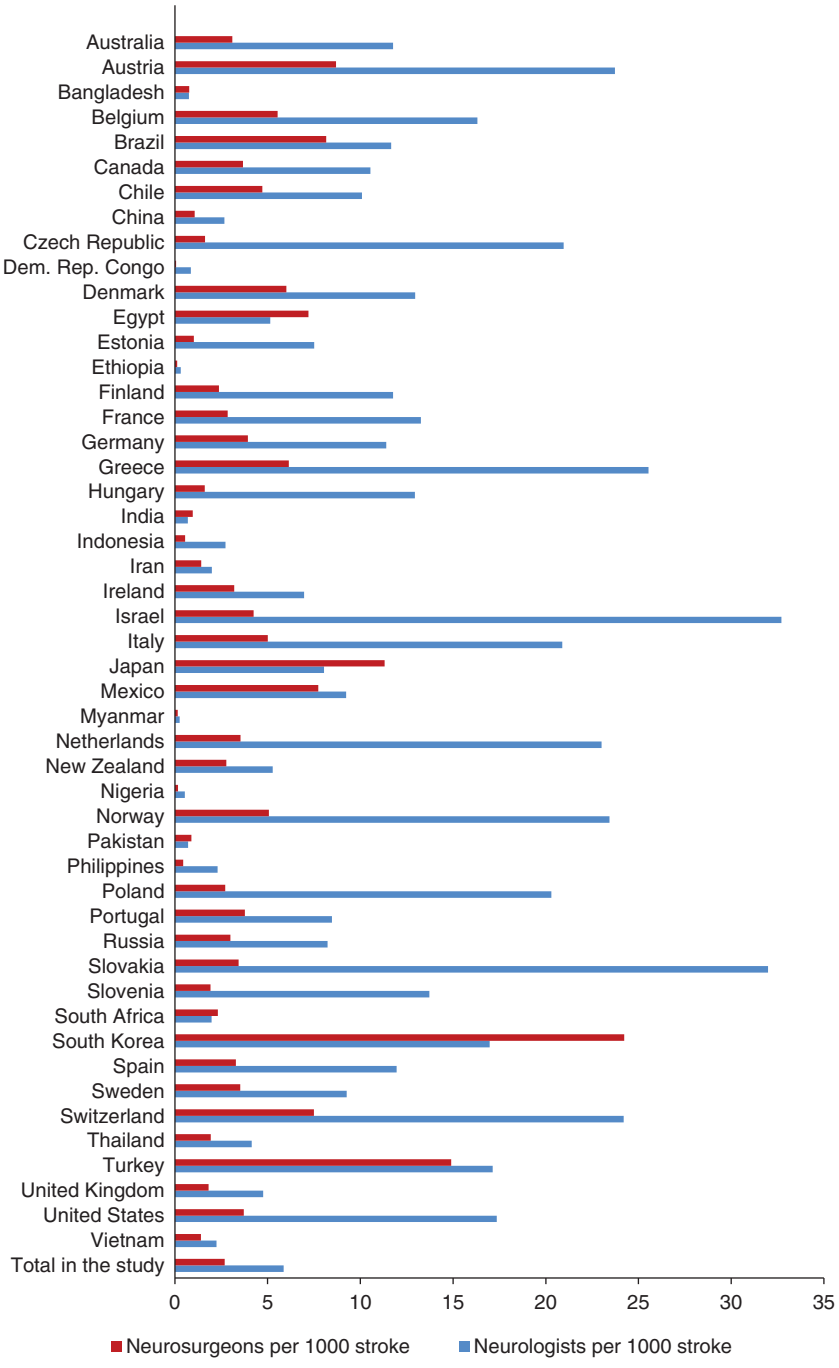
[a]Incidence in thousands in the year 2010 according to the Global Burden of Disease Study.[12]

that plan to develop a new, or revise an existing, stroke training curriculum.

Notably, in many countries, the main treating specialty for stroke is internal/general/geriatric medicine. Although risk factors for stroke and acute complications fall largely in the field of these specialties, the differential diagnosis and long-term complications are neurological. Therefore, neurologists well trained in general medicine may be best suited to treat stroke patients.

Specialist training in medicine and neurology is rapidly changing, with a trend towards subspecialization.[13] In the English literature, a subspecialty in stroke was first suggested in 1997,[14] and then established in 2003 in the USA[15] and in 2004 in the UK.[16] Later, subspecialty training in neurovascular interventions[17] and neurocritical care[18] has been set up in the USA. Even working fulltime in a hospital, the so-called neurohospitalist has been suggested to be a specialized group of neurologists.[19] A policy paper on what European young neurologists considered important in stroke training has been published[20] but has received little attention since. Despite harmonization of higher education in Europe through the Bologna process, the education and healthcare systems still differ widely within the continent. Basic medical degrees are mostly not involved in this European unification, and specialist training not at all. To our knowledge, no other attempts exist for

Figure 2. Number of neurologists and neurosurgeons per 1000 annual incident stroke patients.



harmonizing medical education internationally. The data published here provide new insights into how stroke is being taught globally and may serve to help build collaborations between different systems and thus converge education in the future.

A recent literature review of medical education in the field of neurology failed to identify any articles comparing specialist training programs in neurology or stroke.[21] There is very little data on stroke education overall. In 1992, primary care physicians' and second year medical students' knowledge on stroke was studied in Minnesota, USA, finding disturbing knowledge gaps in both groups.[22] In 1995, a report on undergraduate and postgraduate training in cerebrovascular disease,

Table 2. Stroke-specific degrees by country.

	France	Hungary	Ireland	Israel	Japan	Mexico	Switzerland	Thailand	UK	USA	ESO
Stroke degree type	Academic degree	State License (previously Diploma of Hungarian Stroke Society)	Academic degree	Fellowship	Certification by Japan Stroke Society	Academic degree	Certification by Swiss Neurological Society	Academic degree	Academic degree	Certification by American Board of Psychiatry and Neurology	Master in Stroke Medicine co-hosted by the ESO and Donau University Krems
Initiation year	1998	2014 (Licen.) 2002 (Dipl)	2009	2011	2003	1990	Early 1990s	2005	2004	2003	2006
Degree holders	>500	60 (Dipl.)	N.A.	N.A.	3657	~50	>100	40	N.A.	~1200	~100
Specialists entry requisite	Neurology, Surgery, Radiology, Pediatrics, Cardiology, Vascular surgery, Rehab med.	Neurology, Cardiology, Internal medicine	Medical degree	Neurology, Neurosurg., Internal medicine	Neurology, Neurosurg, Radiology, Pediatrics, Internal/ Emergency/ Rehab med.	Neurology	N.A	N.A.	Neurology, Cardiology, Internal medicine, Geriatrics, Clinical pharmacol, Rehab med.	Neurology	
Duration (year)	2	2	0.75	1	3	1	1	2	2	1	2.5
Brief description of stroke degree content	Theoretical: six modules (two days each); Practical: Min. one year as resident or min. six months as assistant in accredited stroke unit and at least 20 duties in accredited stroke unit	N.A.	Theoretical: seven7 modules (two days each)	Acute stroke unit care, stroke clinics, neuro-sonology, stroke meetings, contact with stroke rehab, research project	Three-year experience of stroke patients care in training site	Theoretical: Courses Research projects Participation in clinical and academic sessions Practical: Stroke clinic duty	Clinical education in stroke medicine and ultrasound, final exams	Stroke fellowship program include acute stroke treatment, prevention, and neurosonology	Theoretical and practical training	Theoretical and practical training	Theoretical: Four weeks in Austria, online studies, master's thesis Practical: Four weeks in international stroke centers of excellence

ESO: European Stroke Organisation. See Online Panel B for websites and contact details.

Table 3. Scientific stroke societies and World Stroke Organization (WSO) membership by country.

Country	National scientific stroke society	WSO organizational members scientific/support	WSO individual members	WSO individual members per 10 million population
Australia	+	1/1	215	96
Austria	+		14	17
Bangladesh	+	1/–	3	0.2
Belgium	+	1/–	11	10
Brazil	+	2/1	38	2
Canada	+	2/1	65	19
Chile	No		6	4
China	+	1/–	806	6
Czech Republic	+		6	6
Dem. Rep. of the Congo	No		1	
Denmark	+	1/–	3	5
Egypt	+		56	6
Estonia	+		0	
Ethiopia	No		0	
Finland	+	1/1	16	30
France	+	1/–	13	2
Germany	+	1/–	45	6
Greece	+	1/–	5	4
Hungary	+		2	2
India	+	–/2	50	0.4
Indonesia	+	1/–	16	1
Iran	No	2/–	105	14
Ireland	+		11	24
Israel	No	–/1	5	7
Italy	+		22	4
Japan	+	2/–	100	8
Mexico	+		7	1
Myanmar	No		5	1
Netherlands	+		13	8

(continued)

Table 3. Continued

Country	National scientific stroke society	WSO organizational members scientific/support	WSO individual members	WSO individual members per 10 million population
New Zealand	+	–/1	23	52
Nigeria	+	1/1	17	1
Norway	+		9	18
Pakistan	+	1/–	4	0.2
Philippines	+	1/–	10	1
Poland	+	1/–	5	1
Portugal	+	1/–	7	7
Russia	+		5	0.4
Slovakia	+		1	2
Slovenia	+		1	5
South Africa	+	0/2	1	0.2
South Korea	+	1/–	57	12
Spain	+	1/–	19	4
Sweden	No		10	11
Switzerland	+	1/1	19	24
Thailand	+	1/–	46	7
Turkey	+	1/–	9	1
United Kingdom	+	2/2	66	11
United States	+	2/3	99	3
Vietnam	+		7	1
Total in the study		**32/17**	**2054**	**4**
Excluded countries		**7/3**	**127**	

based on a survey of 40 centers in USA and Canada, concluded that stroke was hardly being taught at all during the course of basic medical training or specialist training in internal medicine.[23] When stroke components have been introduced to basic medical training, retained learning and student satisfaction were demonstrated in a study at the University of Massachusetts.[24] Neurology specialist curricula and training practices have been evaluated on national level in Finland, but only published in Finnish.[25] It is quite possible that there are many other national and nationally published studies on specialist training which we were not able to identify. As specialist medical training in general serves national demand, details are often not available in English or published in the international literature. We were positively surprised to learn of the 11 existing curricula described in Table 2 and Online Panel B. For most countries, the language barrier prevents gaining detailed data on their national specialist training programs based on publicly available materials alone. Such data are crucial for planning of new curricula, revision of existing curricula, any attempts at harmonization, and to inform policies around international mobility of clinicians.

We observed marked differences in the numbers of neurologists and neurosurgeons by country (Figure 2).

All the 10 countries with > 20 neurologists/1000 stroke cases per year were in Europe, while some European countries such as Sweden, UK, and Ireland had substantially fewer—these were the same countries where stroke was less often treated by neurologists. Similarly, there were more neurosurgeons than neurologists in Japan and South Korea, the countries where a significant number of stroke patients were treated by neurosurgeons. Our data provide no answer as to whether the observed differences in treatment practices are a consequence of the available workforce or vice versa. Overall resource of neurologists and neurosurgeon were low in low- and middle-income countries (Figure 2). A possible effective strategy for these countries may be the engagement of their nationals in diaspora in high-income nations who have acquired high levels of skills in stroke medicine to use their expertise and experiences to help build effective systems in their home nations.[26]

Our survey was limited to only two responses per country. We sought national experts to help identify existing literature on specialties treating stroke patients. Very little published data were identified, and therefore, most of the estimates are based on expert opinion only. These opinions represent only limited geographic locations and select, more often academic, institutions. It is also possible the national experts missed some existing published data. Therefore, our estimates may not be accurate and probably overestimate specialist involvement in stroke care overall. This underlines the need to collect and publish more high-quality data on medical specialists treating stroke patients which can be used for planning the basic and continuous education of these doctors. Also, the interesting finding of how care of stroke patients is divided equally between neurologists and neurosurgeons in many countries suggests a more collaborative approach might be warranted in medical education, and at scientific society level between these specialties. Finally, our survey was performed in 2014 prior to the publication of the positive endovascular clot retrieval trials. For this reason, we did not collect data on training of interventional neuroradiology. This is an important topic and should be included in future updates of our survey.

To conclude, stroke medicine is practiced by doctors of various training background in different countries of which few have specific training programs for stroke. Still, most do have a scientific society, the first requirement to start evolving such curricula. In many countries, stroke patients are not treated by doctors specialized in stroke medicine, but rather by generalists. Treatment of stroke patients by specialists has been associated with better conformance with guidelines, shorter hospital stays, and improved patient outcomes.[6,27,28] Thus, an efficient training system providing stroke specialists would likely have direct benefit on patient outcomes. It would serve stroke patients well to have more stroke specialists taking care of them. No comprehensive data have previously been compiled on the variance of different national practices of educating and scientifically organizing stroke specialists. We hope our data serve to inspire developments in countries where such systems are yet to be implemented, and to promote interaction between existing national organizations.

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Authors' contributions

AM conceived and co-ordinated the project and drafted the manuscript. All authors collected data, interpreted the data, and edited the manuscript for intellectual contribution.

Declaration of conflicting interests

The author(s) declared the following potential conflicts of interest with respect to the research, authorship, and/or publication of this article: All authors are members of the WSO Young Stroke Professionals Committee and/or the Board. WSO is the global body for advancement of stroke medicine. Prof Brainin is the head of the Master in Stroke Medicine training program at the Donau University Krems.

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